Sheet No.2 — Combined Stresses

1. Derive the equation that gives the value of the maximum shear stress for an element subjected to stresses σ_x, σ_y *and* τ_{xy}. At what angle does this value occurs?
2. An element subjected to $\sigma_x = \sigma_y = 2_\sigma$ *and* $\tau_{xy} = \sigma$ determine:
   a) The principle stresses and their location
   b) The max shear stress and its orientation
3. Find the principle stresses and the orientation of the principle axes of stress for the following cases of plane stress:

a) $\sigma_x = 40\text{MPa}$, $\sigma_y = 0$, $\tau_{xy} = 80\text{MPa}$	*b)* $\sigma_x = 140\text{MN/m}^2$, $\sigma_y = 20\text{MN/m}^2$, $\tau_{xy} = -60\text{MN/m}^2$	*c)* $\sigma_x = -120\text{N/mm}^2$, $\sigma_y = 50\text{N/mm}^2$, $\tau_{xy} = 100\text{N/mm}^2$
d) $\sigma_x = -10\text{bar}$, $\sigma_y = -4\text{bar}$, $\tau_{xy} = 8\text{bar}$	*e)* $\sigma_x = 10{,}000\text{psi}$, $\sigma_y = 20{,}000\text{psi}$, $\tau_{xy} = -6{,}000\text{psi}$	*f)* $\sigma_x = 0$, $\sigma_y = 37\text{kg/mm}^2$, $\tau_{xy} = 13\text{kg/mm}^2$

4. For the state of stress given in the previous problem, find the state of stress components on an element inclined at 30° to the xy axes.
5. If the minimum principle stress is -7MN/m^2, find σ_x and the angle which the principle stress axes make with the xy axes for the case of plane stress illustrated in fig. (2.1)
6. A single horizontal force **P** of magnitude 900N is applied to end *D* of lever *ABD* [fig. (2.2)] Knowing that portion *AB* of the lever has a diameter of 36mm, determine:
   a) The normal and shearing stresses on an element located at point *H* and having sides parallel to the *x* and *y* axes
   b) The principle planes and the principle stresses at point *H*.
7. Two members of uniform cross-section 50x80mm are glued together along plane a- a, which forms an angle of 25° with the horizontal. Knowing that the allowable stresses for the glued joint

are σ=800kPa and τ=600kPa, determine the largest axial load **P** which may be applied.

8. A 60 mm diameter steel rod supports a 12kN tensile load and is subjected to a twisting moment of 1.5kJ as shown in fig. (2.3). Determine the maximum tensile and the maximum shear stresses in the rod.
9. The state of stress at a given point is known to be uniaxial with $\sigma_y = \sigma_0$ as drawn in fig. (2.4). Determine the normal stress and the shearing stress on the plane *BDF* which forms equal angles with the three coordinate systems. [*Hint: Consider the transformation of stress in the vertical plane containing points A, C and F.*)
10. A long, thin walled pipe is subjected to an internal pressure p and uniform axial tensile load F. The radius and thickness of the pipe are r=18cm, and t=0.2cm. The axial and tangential stresses under internal pressure are $\sigma_a = pr/2t$ and $\sigma_\theta = 2\sigma_a$. The normal stresses at a point A on the surface of the cylinder are restricted to $\sigma_{x'}$=300 N/mm^2, $\sigma_{y'}$=200 N/mm^2, while shear stress $\tau_{x'y'}$ is not specified. Determine the values of p and F. Note that x and y are in the axial and radial directions, respectively. The x',y' axes make an angle of 30° with the x , y axes.
11. A thin walled cylindrical pressure vessel of 30cm radius and 0.25cm wall thickness has a welded spiral seam at an angle of 30° with the axial direction. The vessel is subjected to an internal gage pressure of p MPa and an axial load of 2 π kN applied through rigid end plates. Find the allowable value of p if the normal and shearing stresses acting simultaneously in the plane of welding are limited to 3 MPa and 1 MPa, respectively.
12. Solve problem 3.,.using Mohr's circle .
13. Solve problem 5.,.using Mohr's circle.
14. The grain of a wooden member forms an angle of 15° with the vertical. For the state of stress shown in fig. (2.5) and with the aid of Mohr's circle determine:

a) The shearing stress parallel to the grain
b) The normal stress perpendicular to the grain.

15. For the given fig. (2.6) determine the state of stresses at points A and B and find the principle stresses at each point. Which point is more critical?

16. Draw Mohr's circle for the following given state of stresses: Fig (2.7)

17. A rectangular aluminum thin plate with the dimensions shown in fig. (2.8) is subjected to the stresses σ_x=-100MPa , σ_y=115MPa and τ_{xy}=20MPa . If the elastic constants of the plate material are: E=77500MPa and G=29500MPa, determine the change in length of the diagonal "AC".

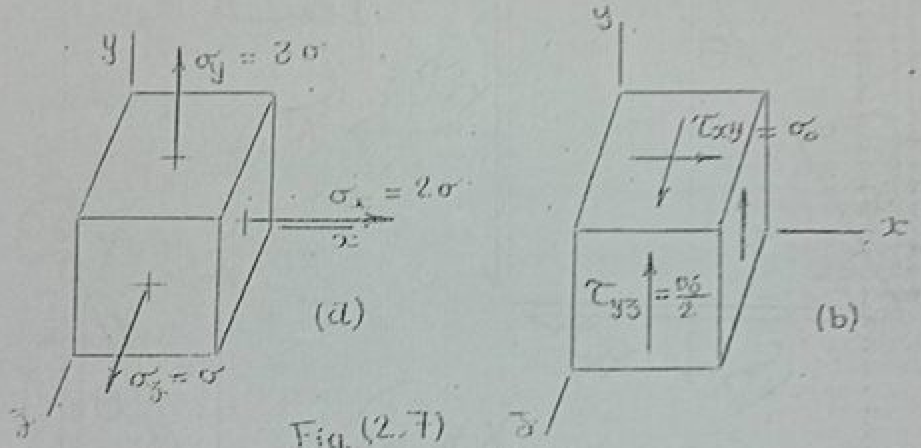


Fig. (2.7)

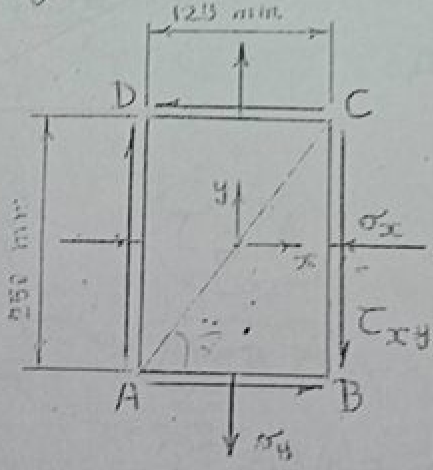


Fig. (2.8)

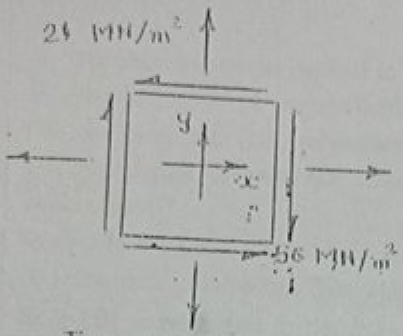


Fig. (2.1)

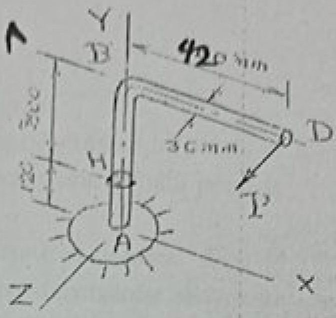


Fig. (2.2)

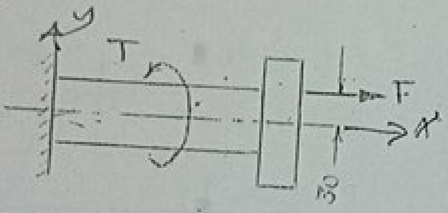


Fig. (2.3)

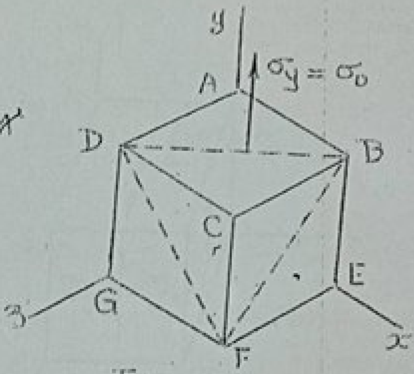


Fig. (2.4)

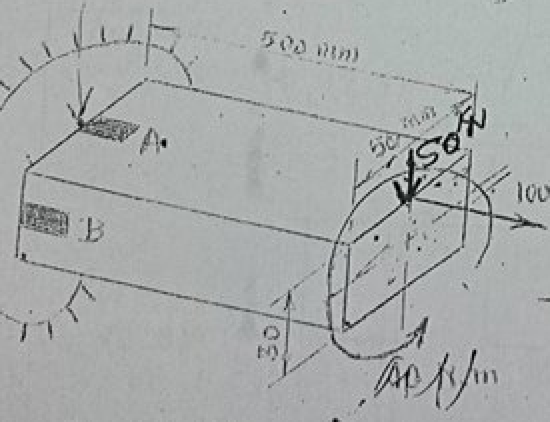


Fig. (2.6)

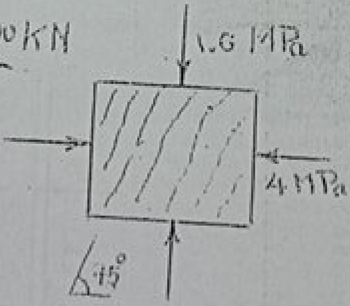


Fig. (2-5)